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(71) Applicant(s):
Engineered Arts Ltd
E1-E3 Church View Business Park,
Bickland Water Road, Falmouth, Cornwall, TR11 4FZ,
United Kingdom

(72) Inventor(s):
Will Jackson
Simon Osborn

(74) Agent and/or Address for Service:
Forresters IP LLP
Port of Liverpool Building, Pier Head, LIVERPOOL,
L3 1AF, United Kingdom

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GB 2411435 A **DE 102016101865 A1**
US 3012420 A

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(54) Title of the Invention: **A universal ball joint**
Abstract Title: **A universal ball joint**

(57) A universal ball joint is provided. The universal ball joint comprises: a ball element 4; a post 3 projecting radially from an exterior surface of the ball element 4; and a ball retaining housing 6. A guide 8 which is configured to receive the post 3 and constrain movement of the post 3 to rotation to rotation in a single spatial plane, is provided on an interior surface of the ball-retaining housing 6, and the ball-retaining housing 6 is formed from two or more housing parts that combine to capture the ball element 4.

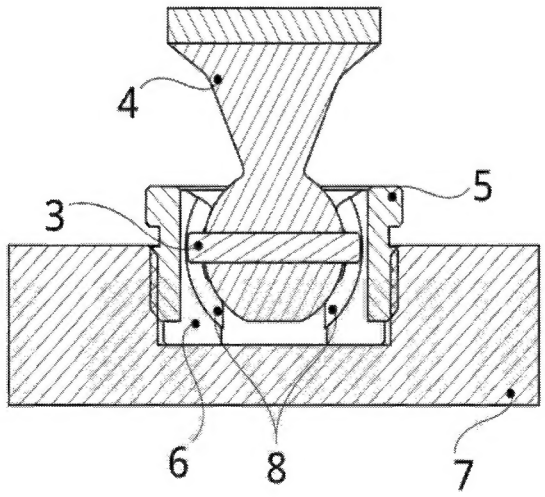

Figure 1

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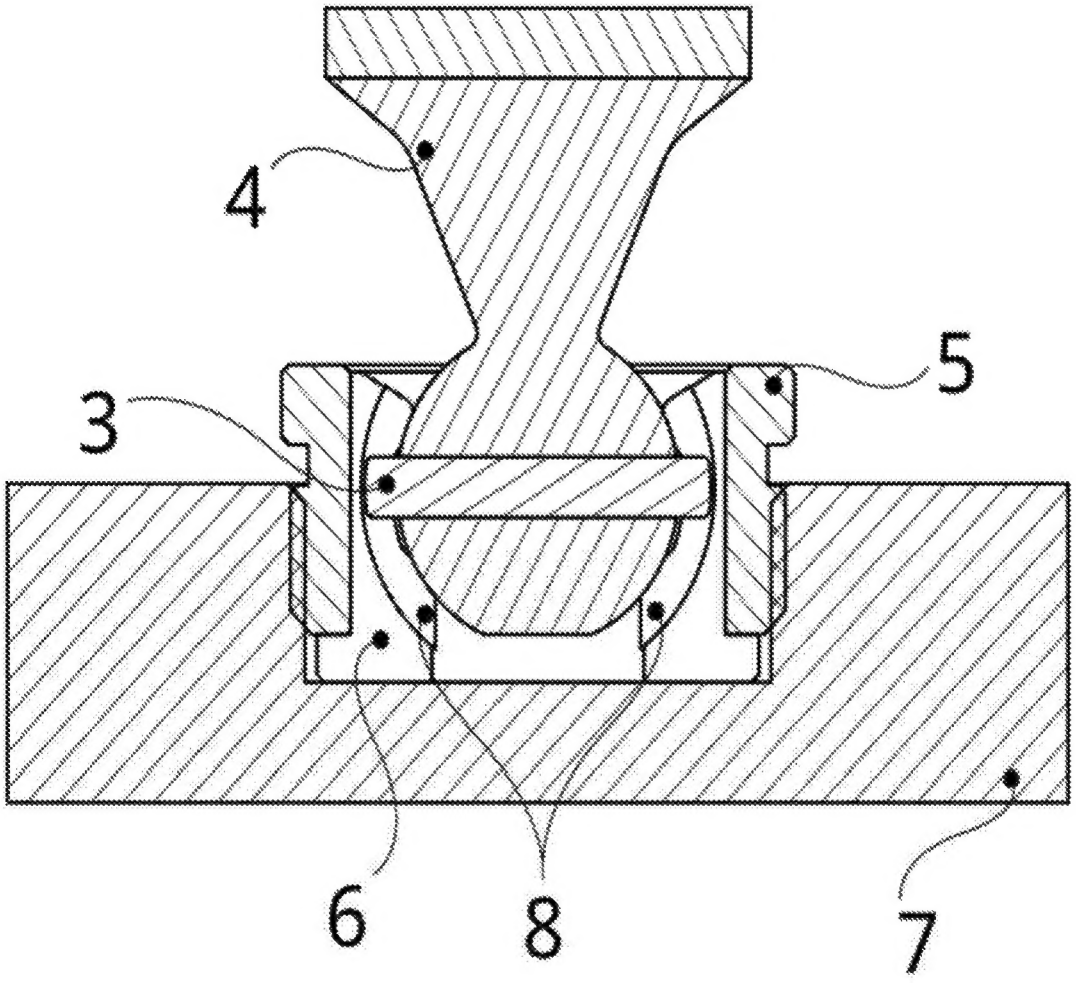

Figure 1

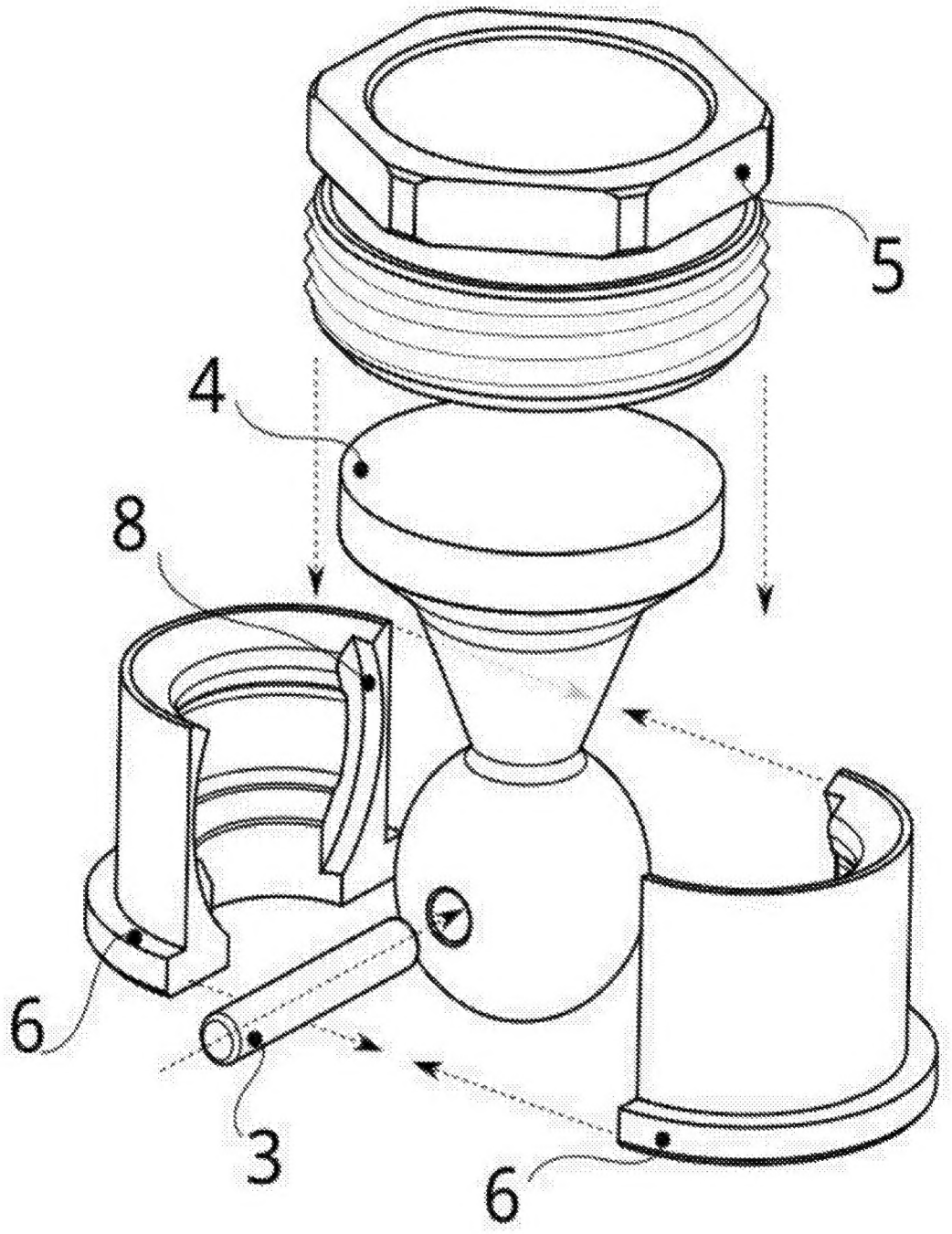

Figure 2

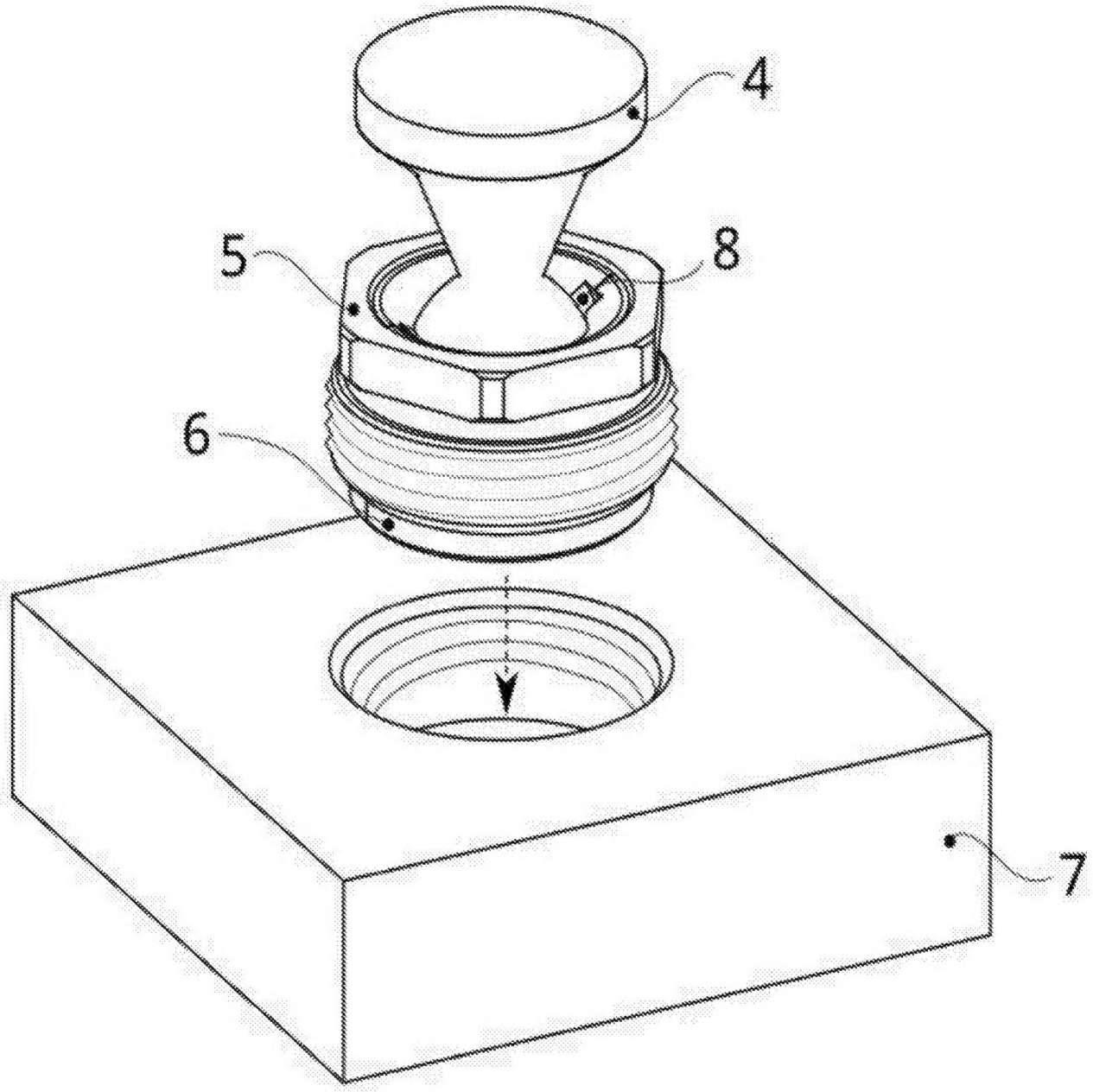

Figure 3

A universal ball joint

The present disclosure relates to a universal ball joint.

Ball joints are a well known mechanical connection method permitting three degrees of rotational freedom between the connected bodies.

Ball joints in which one axis of rotation is mechanically locked (leaving two degrees of freedom between the joined bodies) are also found in industry. These are commonly referred to as universal ball joints, since they constrain the connected bodies in the same way as a traditional universal joint.

The locked axis permits the transmission of torque around said axis between the bodies connected by the joint. This torque can either be used for driving rotational motion of a second body from a rotating first body, or else for preventing rotational motion of a second body relative to a fixed first body.

This type of joint is particularly advantageous in machines and mechanisms with a high degree of articulation, where compound motions occur across multiple planes/axes. Such mechanisms occur commonly in devices with parallel kinematics, for example in the field of robotics.

A universal ball joint shares the same degrees of freedom as a traditional universal joint, while offering practical advantages in certain situations. Particularly it is much easier to achieve low or zero mechanical backlash in a universal ball joint, as well as higher friction and therefore higher effective stiffness and damping characteristics.

The use of universal ball joints, however, is limited by difficulties and/or complexites that are typically characteristic of manufacturing and/or assembling such joints.

CN108177159B discloses a prior art universal ball joint, wherein a ball element attached to a first body is augmented with a radial flange. The flange runs in a groove inside a first housing element, which restricts the movement of said ball element within said first housing element to a single axis of rotation. The external surface of said first housing element is itself substantially spherical, and is augmented with a further protruding flange, arranged in an orthogonal plane to the orientation of the flange connected to the initial ball element. The flange on the exterior of this first housing element then engages with a complementary groove on the internal surface of a second housing element, which permits the first housing element to move relative to the second housing element about a single axis of rotation. The combined effect of these two rotations is to facilitate two orthogonal degrees of rotational motion between the first body and the second housing element, such that a universal ball joint is provided.

US8353776B2 discloses an alternative prior art universal ball joint. In this design, the ball element is adjusted to have an elliptical cross section as opposed to the circular cross section of a sphere. The elliptical ball is mounted into a correspondingly shaped recess. In this way, the two orthogonal axes of rotation are inherently established by the shape of the ball.

The present invention arose in a bid to provide an improved universal ball joint allowing for simple, cost-effective manufacture and assembly, whilst allowing for increased adjustability, and a compact size.

Representative features are set out in the following clauses, which stand alone or may be combined, in any combination, with one or more features disclosed in the text and/or drawings of the specification.

According to the present invention in a first aspect, there is provided a universal ball joint comprising a ball element, a post projecting radially from an exterior surface of the ball element, and a ball-retaining housing, wherein a guide, which is configured to receive the post and constrain movement of the post to rotation in a single spatial plane, is provided on an interior surface of the ball-

retaining housing, and the ball retaining housing is formed from two or more housing parts that combine to capture the ball element.

With the housing split into parts that combine to capture the ball element, and the provision of the guide for receiving the post and constraining movement thereof to rotation in a single spatial plane, a greatly simplified construction of universal ball joint is possible, which may be reduced in size.

The universal ball joint preferably further comprises a mounting member and a clamping member for clamping the ball retaining housing against the mounting member. The arrangement is preferably such that with the clamping force applied, the ball retaining housing is locked against rotation relative to mounting member but with the clamping force released, the ball retaining housing may be rotated relative to the mounting member. By such an arrangement, the orientation of the universal ball joint may be readily adjusted in-situ. Moreover, the clamping member may be configured to hold the two or more housing parts together, which may further aid in reducing part count and simplifying construction.

Further, preferred, features are presented in the dependent claims.

There is uniquely provided a universal ball joint, which offers at least the following advantages over the prior art:

- low part count
- ease of manufacture
- ease of assembly
- ease of adjustment / rotational setting of assembled parts
- extremely compact assembled joint

By way of example, in contrast to the arrangement of CN108177159B, the present arrangement is comparatively easy to manufacture, requiring fewer precision manufactured surfaces, whilst also facilitating increased adjustability of the assembled joint.

By way of further example, in contrast to the arrangement of US8353776B2, the present arrangement is again easier to manufacture, whilst offering increased contact area contact area between the ball and the recess, and increased adjustability.

Non-limiting embodiments of the invention will now be discussed with reference to the following drawings:

Figure 1 shows sectional view of a universal ball joint according to a first embodiment;

Figure 2 shows an exploded perspective view of the universal ball joint of Figure 1; and

Figure 3 shows an assembled perspective view of the universal joint of Figure 1 prior to attachment to

With reference to the figures, there is shown a universal ball joint according to a first embodiment, which comprises a ball element **4**, a post 3 projecting radially from an exterior surface of the ball element **4**, and a ball-retaining housing 6. A guide 8, which is configured to receive the post 3 and constrain movement of the post 3 to rotation in a single spatial plane, is provided on an interior surface of the ball-retaining housing 6. The ball retaining housing 6 is formed from two or more housing parts that combine to capture the ball element.

In the present arrangement, as best seen in Figure 2, the ball retaining housing is split into two halves. In alternative arrangements, although less preferable, it could be split into further parts.

Although not limited as such, the ball retaining housing 6 of the present arrangement comprises a cylindrical outer face, as best seen in Figure 2. Relative to this face, the ball retaining housing is split axially. Whilst such an arrangement is preferred, in alternative arrangements the ball retaining housing could, for example, rather be split radially, i.e. the split could be perpendicular to the split shown. The alternative orientations of the split are not dependent on the provision of a cylindrical outer face, which is used simply as a frame of reference.

The guide 8 preferably comprises a groove as shown, which may be formed in an inner surface of the ball retaining housing. It should be appreciated that the guide may be otherwise formed. Any alternative form of guide that similarly constrains movement of the post 3 to rotation in a single spatial plane will be suitable.

The guide 8, irrespective of form, is preferably formed at a junction between two of the housing parts, as best seen in Figures 2 and 3. It most preferably extends along the junction, as shown. In the present arrangement, a half groove is formed at each junction, wherein as the two housing parts are brought together to capture the ball element 4, the half grooves combine to form the groove, wherein the post is received thereby. With the post received/trapped by the groove, one axis of rotation is mechanically locked leaving two degrees of freedom.

The form of the post 3 is not particularly limited, as will be appreciated by those skilled in the art. In the present arrangement the post 3 comprises a pin that is received by an opening in the ball element. The pin protrudes radially on opposite sides of ball element to provide a pair of posts. Whilst such an arrangement is preferable for ease of manufacture, the post(s) need not be formed in this manner. For example, one or more posts could be integrally formed with ball element, by machining or otherwise. The shape of the post may be varied from the cylindrical pin, it could be, for example, have a domed tip, or otherwise.

As is particularly preferred, in the present arrangement there is further provided a mounting member 7 and a clamping member 5 for clamping the ball retaining housing 6 against the mounting member 7.

In the present arrangement, as is preferred, the clamping member 5 is unitarily formed. It most preferably comprises a collar, as shown, comprising a through hole and surrounding the ball retaining housing. By such arrangement it may hold the two or more housing parts together. It could be otherwise formed to perform such function. It is preferable that the clamping member comprises a substantially cylindrical inner face, although this of course need not be the case. As discussed, the ball retaining housing may comprise a cylindrical outer face. Where

there are a pair of cylindrical faces provided they may substantially conform to one another. It should be appreciated that the configuration of the housing parts may be such that the clamping member need not be configured to hold the housing parts together. The housing parts could, in alternative arrangements, be otherwise held together. They could, for example key with one another, or otherwise.

The clamping member 5 is preferably threaded. Most preferably, as shown, it comprises a threaded outer surface for engaging a threaded opening in the mounting member. Such an arrangement allows for a simple construction and for easy adjustability, as discussed below. An alternative mechanical attachment to the mounting member may otherwise be provided.

The clamping member 5 and the ball retaining housing 6 may take various forms that allow for the suitable application of a clamping force to the ball retaining housing by the clamping member. In the present arrangement, however, the ball retaining housing is provided with a flange. The flange as shown extends radially from a base of the ball retaining housing. It may extend around the entire periphery of the clamping member.

The arrangement is such that as the clamping member 5 is tightened up to the mounting member 7, the flange (or similar alternative feature) of the ball retaining housing 6 is clamped in place by the tightening action. This clamping action (in combination with the post 3 and guide 8) locks off the rotation of the ball member with respect to the mounting member 7, permitting the transmission of torque between the ball element 4 and the mounting member 7 about the locked axis.

A further advantage of this design and assembly method is that the alignment between the ball element 4 and the mounting member 7 may easily be adjusted / set as required, by:

i. loosening the clamping force between the clamping member 5 and the mounting member 7.

ii. rotating the ball element 4 to a desired angle (the post 3 and ball retaining housing 6 will rotate with the ball element 4, whilst the clamping member 5 and the mounting member 7 remain independent of this rotation).

iii. re-tighten the clamping member 5 to the mounting means 7, restoring the clamping force that locks the rotation of the ball retaining housing 6, and thereby also locks rotation of the ball element 4.

Such functionality is provided with an extremely low part count, and simplified manufacture and assembly.

The ball retaining housing is preferably manufactured from a low friction, wear-resistant material, for example an engineering plastic. It may otherwise be formed from metal or otherwise.

Numerous alternative arrangements and modifications to the embodiments as described herein will be readily appreciated by those skilled in the art within the scope of the appended claims. In particular, features of the described embodiments may be readily combined.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Although certain example embodiments of the invention have been described, the scope of the appended claims is not intended to be limited solely to these

embodiments. The claims are to be construed literally, purposively, and/or to encompass equivalents.

Claims

1. A universal ball joint comprising a ball element, a post projecting radially from an exterior surface of the ball element, and a ball-retaining housing, wherein a guide, which is configured to receive the post and constrain movement of the post to rotation in a single spatial plane, is provided on an interior surface of the ball-retaining housing, and the ball retaining housing is formed from two or more housing parts that combine to capture the ball element.

2. A universal ball joint as claimed in Claim 1, wherein the guide comprises a groove.

3. A universal ball joint as claimed in Claim 1 or 2, wherein the guide is formed at a junction between two of the housing parts.

4. A universal ball joint as claimed in any preceding claim, wherein the guide extends along the junction.

5. A universal ball joint as claimed in any preceding claim, further comprising a mounting member and a clamping member for clamping the ball retaining housing against the mounting member.

6. A universal ball joint as claimed in Claim 5, wherein the clamping member is unitarily formed.

7. A universal ball joint as claimed in Claim 5 or 6, wherein the clamping member comprises a collar, which surrounds the ball retaining housing.

8. A universal ball joint as claimed in any of Claims 5 to 7, wherein the clamping member is configured to hold the two or more housing parts together.

9. A universal ball joint as claimed in any of Claims 5 to 8, wherein the clamping member comprises a threaded outer surface for engaging a threaded opening in the mounting member.

10. A universal ball joint as claimed in any of Claims 5 to 9, wherein the ball retaining housing comprises a flange against which a clamping force is applied by the clamping member.

11. A universal ball joint as claimed in any of Claims 5 to 10, wherein the clamping member comprises a substantially cylindrical inner face.

12. A universal ball joint as claimed in any of Claims 5 to 11, wherein, with the clamping force from the clamping member released, the ball retaining housing is free to rotate relative to the mounting member.

13. A universal ball joint as claimed in any preceding claim, wherein the ball retaining housing comprises a substantially cylindrical outer face.

14. A universal ball joint as claimed in any preceding claim, wherein the ball element comprises a substantially spherical exterior profile.

15. A universal ball joint as claimed in any preceding claim, wherein the post comprises a pin.

16. A universal ball joint as claimed in Claim 15, wherein the pin is received by an opening in the ball element.

17. A universal ball joint as claimed in any preceding claim, wherein a pair of posts are provided which project from opposed sides of the ball element.

Intellectual Property Office

Application No:	GB2206132.9	**Examiner:**	Mr Kevin Hewitt
Claims searched:	1 to 17	**Date of search:**	19 October 2022

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	GB 2411435 A (NIFCO et al.) See especially Figures 1-8.
A	-	US 3012420 A (SCHAEDLER) See especially all Figures.
A	-	DE 102016101865 A1 (VOLKSWAGEN) See especially Figures 2 & 3.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

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Worldwide search of patent documents classified in the following areas of the IPC

B25J; F16C

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, Patent Fulltext

International Classification:

Subclass	Subgroup	Valid From
F16C	0011/06	01/01/2006
B25J	0017/02	01/01/2006

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